agricultural research

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Fateful Triangle

In a world struggling against hunger, two salient needs have captured the headlines: increasing food supplies and limiting population growth. But a third need has emerged to form a fateful triangle, and it may prove of prime importance if mankind is to avert famine in another generation. It hinges on drastically trimming the staggering statistics of food losses—in field and storage—through waste, erosion, spoilage, diseases, pests, and improper storage. Indeed, experts estimate that these losses claim fully one-half the world's food supply.

What is the quickest way to reduce these losses? Probably by controlling post-harvest losses, those occurring between the farmer's field and the consumer's table. At an international conference on stored-product entomology hosted by ARS, some 200 scientists from 27 countries noted that 30 to 40 percent of the crops harvested in the developing countries never get to consumers. The scientists called for comprehensive adoption of existing technology to hold these losses to 5 percent or less.

Over the years, agricultural science has developed ways of controlling insects that attack stored grain. These methods include the hermetic storage of grain in air-tight bins to deprive insects of oxygen, irradiation to kill insects in grain, improved drying of grain before storage to suppress mold growth, and many more.

But adapting current technology to the needs of developing countries cannot be achieved overnight. The hard fact is that these nations, besides lacking funds, practice subsistence agriculture under greatly differing agricultural and social conditions. The urgent mission, therefore, is for simple but effective low-cost techniques to fill specific niches. One such ARS-developed approach involves traps baited with a sex attractant or pheremone. Once trapped, the insect can be killed with an insecticide or infected with a disease that it will carry to others of its species. Another approach, evaluated by ARS in work with farmers, is a simple yet safe insecticide drip-on method for treating 50-bushel increments of wheat as they are augered into a storage bin—at a fraction of the cost of a purchased spraying unit. It employs a calibrated gallon milk jug containing freshly mixed water and malathion which is fed through a length of plastic tube onto the wheat kernels.

A heroic effort must get underway to help a hungry world fully exploit its food supply. No less is acceptable before the grim specter of mass famine.

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COVER: To determine soybean harvesting losses, agricultural engineer W. Ralph Nave and research assistant T. Frank Carter check for shattered and lost beans while University of Illinois student James S. Bloomstrand records their findings. A redesigned combine featuring new headers and an air-jet system developed by Mr. Nave are being tested by researchers to minimize harvesting losses (1074X1667–33). Article begins on page 3.

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To study harvesting losses, a test strip of soybeans is harvested by an experimental combine with an air header system. Mr. Nave assures accuracy of stalk loss counts by catching and removing stalks that would otherwise be dragged back into the harvested test strip when the combine backs out of the field (1074X1664–31A).

Reducing soybean harvest losses

HARVESTING LOSSES of soybeans—normally amounting to nearly 10 percent of the crop—can be reduced substantially through improved combine design.

One innovation for improving efficiency of combines is an air-conveyor header developed by ARS agricultural engineer W. Ralph Nave, in cooperation with colleagues of the Illinois Agricultural Experiment Station, Urbana. Mr. Nave installed air jets several inches ahead of a floating cutterbar to help insure a smooth flow of plant material and shattered beans over the cutterbar and onto an extended grain platform. In field tests, the combine modification reduced loss to less than 3 percent of the yield when beans contained 12 percent moisture.

The engineering development may become one of few improvements in soybean harvesting since the 1920's. In 1927, an on-farm survey by researchers of the Illinois Station showed that harvest losses of soybeans in the State averaged 11.6 percent of the crop. In a 1968 survey of Illinois, Arkansas, and Mississippi farms, Mr. Nave and Illinois agricultural engineers found average losses were still high—9.2 percent.

Since soybeans became a major crop in the United States, the standard grain combine has been less than ideal for harvesting, Mr. Nave says, because soybeans are physically unlike small

Flexible tubes mounted under the modified combine deliver air at a velocity of 2,500 feet per minute (28 miles per hour) to the front of the cutterbar. The air comes from a fan, which is driven by the combine's engine (1074X1669–7).

A closeup shows the air jet nozzles mounted 6 inches forward of the cutterbar. The air stream picks up shattered beans and loose pods that would otherwise remain in the field. It also prevents beans from rolling down the steep incline from the auger table to the cutter bar and being lost in the field (1074X1663–4).

grains. Consequently, design changes in the combine are needed.

Design change, however, is not all that is needed to curtail harvest loss, Mr. Nave adds. In the 1968 survey he observed that some farmers lost up to 2 bushels of soybeans per acre because of improper combine adjustments.

Another major loss was soybeans left on the stubble. Harvest loss, Mr. Nave says, can sometimes be reduced by as much as 25 percent if a farmer has a floating cutterbar and watches his cutting height closely. But the survey showed that the biggest losses always occurred at the combine header.

To identify causes of combine header losses, Mr. Nave used several techniques. One was to film the action of header components—cutterbar, cross auger, and reel—with a high-speed movie camera mounted on the combine. In the movies, soybeans could be seen in slow motion, shattering, bouncing, and rolling toward the ground.

For field studies, he also built a pull-type framework containing header components. By removing parts of the apparatus, he could study losses caused by movement and vibration of the components.

Employing the experimental header on three varieties of soybeans grown in central Illinois, Mr. Nave cut the plants about 3½ inches above the ground and found that the cutterbar was accountable for about 81 percent of the header loss. The reel and cross auger accounted for 6 and 13 percent of the loss, respectively.

Based on this information, Mr. Nave built a header test stand in the laboratory and tested the theory of using compressed air to prevent shattered beans from landing on the ground. With the indoor arrangement, he was not dependent upon weather and had control of variable conditions.

Plant material was stored, until use, under controlled humidity and temperature. Soybean stalks, with their bases clamped between two boards, could be conveyed to the operating header assembly at simulated ground speeds of combines.

The most practical and effective use of compressed air proved to be directing air at a velocity of 2,500 feet per minute toward the cutterbar from nozzles positioned 15 inches apart and 6 inches in front of the cutterbar, Mr. Nave said.

Harvest losses were reduced significantly only when beans were dry enough to harvest without need for artificial drying. When the laboratory unit was equipped with air jets and a standard cutterbar, header loss of beans containing 13 percent moisture was reduced to 25 percent of the loss observed without air jets. Air jets and a floating cutterbar, together reduced loss by 45 percent.

One season's results of field testing in 30-inch soybean rows have compared closely with laboratory data, Mr. Nave said.

In harvesting narrower (8-inch) rows, Mr. Nave and ARS agronomist Richard L. Cooper are finding that even more shattered soybeans can be saved by the air jets. Plants in the narrow rows were more evenly spaced than those in wide rows, allowing the air stream to work more smoothly.

In harvesting plots of soybeans in narrow rows, the scientists noted that skid pads on the floating cutterbar do not ride a definite row of stubble as they do on both cultivated and non-cultivated wider rows. Accordingly, the stubble is cut closer to the ground, saving some beans.

Unfortunately, soybeans planted in low population and narrow rows tend to set pods close to the ground. The cutterbar sickle cuts through many of these pods, causing shatter loss. Combine headers with air jets may help provide a solution to the problem. □

Mr. Nave takes a soybean sample from the weighing hopper on the combine. The sample will be analyzed for moisture content and mechanical seed damage. The moisture content is directly correlated to harvest losses due to shattering (1074X1663–7).

University of Illinois agricultural engineering students doing field studies in cooperation with ARS scientists check threshing and separating losses through the combine. A tarpaulin is rolled up under the combine and released as the combine moves through the field. The discharge collected on the tarpaulin is analyzed and counted, and harvest losses noted (1074X1666–17).

Left: Mr. Becvar and Dr. Malmquist (foreground) collect blood samples from herpes-free ponies for use in propagating equine infectious anemia (EIA) virus in a herpes-free tissue culture at the National Animal Disease Center (0874X1253–16). ***Below:*** *Pathologist Dean Barnett inspects a microscope slide containing sections of horse tissue. He will evaluate the tissue through fluorescent antibody techniques to determine the presence or absence of EIA virus (0874X1252–2).*

Antigen for EIA diagnosis

Use of an improved antigen for diagnosing equine infectious anemia (EIA) should speed eradication of a disease which is of great concern to owners of pleasure and racing horses.

The antigen was produced at the National Animal Disease Center, Ames, Iowa, in horse dermal, or skin, cell cultures. It is purer, produces more distinct reactions, and is more economical to produce than the presently used antigen recovered from spleens of horses that have the disease. Horses carrying EIA virus are identified by a reaction between the diagnostic antigen and their blood serum.

EIA, a disease involving cells of the vascular system causes debilitation and sometimes death. The disease is not highly contagious. Horses that recover from EIA, however, may remain carriers as long as 13 years and may spread the disease by contact. EIA is also spread by horseflies and unsterilized needles and instruments. Veterinarians advise elimination or strict isolation of infected horses, because no effective control is known or in prospect.

Regulations of USDA's Animal and Plant Health Inspection Service prohibit interstate movement of horses in which EIA is diagnosed, except to slaughter, and to research institutions or isolation on home farms. Many States and Canada also enforce EIA quarantines.

ARS veterinary medical officers Winston A. Malmquist and Dean Barnett and technician C. Stanley Becvar succeeded, where many others had failed, in establishing EIA virus in horse dermal cell cultures as a source of antigen.

The researchers devised a three-step procedure. First, they cultured and infected leucocytes, or white blood cells, from a horse raised in isolation and shown free of contaminating herpes viruses. Then they transferred infected leucocyte cell cultures to cell cultures established from horse spleen tissue. Finally, they transferred fluids from the infected spleen cell cultures to dermal cell cultures.

The researchers confirmed the EIA virus infection was established in the leucocyte cell cultures by incubation until cell destruction was observed. The EIA virus does not destroy cells in spleen and dermal cell cultures, so its presence was verified by inoculating leucocyte cell cultures with fluids from spleen and dermal cell cultures. Cell destruction again confirmed infection.

Dr. Malmquist and his associates used fluids from dermal cell cultures as the antigen source. They separated the virus from the fluids by precipitation with polyethylene glycol, then removed virus cell coats with ether. The antigen produced by this technique can be prepared at the desired concentration for use in diagnosing EIA.

The researchers also adapted a method for standardizing the antigen by radial immunodiffusion so a product of uniform strength can be made available to diagnostic laboratories. Commercial firms have indicated interest in the new antigen.

Unstacking chicken problems

SCENE: Receiving dock of a commercial poultry processing plant. Contaminated dust. Off odors. Heat, rain, or freezing winds, whatever the climate may offer.

SCENARIO: Eight to 10 men are unloading trucks, tossing coops of live poultry onto conveyors which move the coops into the processing plant. Every hour workers manually move 1,000 75-pound coops—12,000 chickens—to meet a quota.

What makes this a bad scene? Unhealthy human environment and bruised birds.

Improvement is on the way. A new chicken coop unstacking machine, the first component of a mechanized coop handling system, has been developed by ARS agricultural engineer Albert D. Shackelford and engineering technician John Holladay at the Richard B. Russell Agricultural Research Center in Athens, Ga. Unlike some proposed semi-mechanical systems, the unit is expected to be adaptable to most processing operations.

In 1973, per capita consumption of chicken totaled 41.4 pounds, including 37.7 pounds of broilers. Retail broiler sales totaled $5 billion. But before the country-fried chicken meets the mashed potatoes on the consumer's table, the live birds must be transported from broiler house to processing plant in coops stacked on live-haul trucks.

Individual coops must be safely unstacked from coops stacked up to 11 high on the truck and then set on a conveyor. At an average of 12 birds per coop (10 per coop during hot summer months, up to 16 during cold winter months), a 6,000-bird-per-hour processing plant requires 500 coops of chickens per hour. Two workers may handle this load. The distances between the coop stacks on the truck and the conveyor are not great—2 to 8 feet, depending on the location of the crates on the truck. The distance tempts workers to toss the coops onto the conveyor, bruising the chickens, perhaps causing them to be condemned, or at best, downgrading the dressed product. Coops dropped or thrown off the truck onto the conveyor are also damaged. Because of an inherently poor working environment and the heavy labor involved, workers are increasingly difficult to find and to keep. Both conditions constitute a major problem to the poultry processing industry; it must turn to mechanization and automation.

The new unstacking machine works like this: A squeeze lift removes a stack of full crates from the haul truck and places it on a conveyor. The conveyor moves the load of crates to an elevator which raises the stack to the top of a tower. Then the top crate is picked up by a series of pneumatic tires and chains and transferred to a second conveyor which takes it to the area where the birds are to be removed and hung on the kill line.

A prototype of engineer Shackelford's design has been installed at a processing plant near Gainesville, Ga., for testing under commercial operating conditions. Based on test results, the unit is capable of handling 12,000 coops per hour with a labor saving potential of three to four workers. Bruising of live birds and damaging of coops are greatly reduced. Importantly, the equipment relieves employees of manual handling of coops.

A powered feed conveyor supplies stacks of standard 10–inch coops to the unstacking tower on demand. Controls on the unit supply one stack of coops into the tower and at the same time position another stack at the entrance for quick transfer to the tower. The coops are moved toward the tower by powered drag chains which travel the length of the conveyor.

An intergral part of the unstacker is the tower conveyor; it positions a stack of coops on the lift platform. The lift platform, which supports and elevates a stack of coops, is raised and lowered by a powered ball-bearing screw; it is driven by a 2-horsepower motor equipped with a failsafe brake to stop the lift platform at control points. Total cycle time from bottom to top and return is less than 20 seconds.

"The unit is simple to construct, it's rugged and reliable even in a dusty atmosphere, and it is not costly or difficult to operate," said Mr. Shackelford. "It handles damaged crates and stacks that get out of alignment, plastic and wooden coops, and mixed stacks."

Are there any limitations? Mr. Shackelford finds no major ones. "The conveyor stores six stacks of six crates at present, if that is a limitation. But there's no reason to believe a longer conveyor or a higher tower couldn't be constructed to increase coop storage and production rates." □

Sterilization affects seed studies

PLANT SCIENTISTS may have to take another look at the results of their biochemical studies on sterilized seeds and other plant tissues.

The reason is that sodium hypochlorite (NaOCl), the chemical traditionally used for sterilization, can alter the metabolism of such tissues.

It was never before suspected that NaOCl—the disinfecting ingredient in common household bleaches—would have any particular effect other than the intended one of eliminating fungi and bacteria from the seeds. Of course, the seeds are thoroughly washed in water after sterilization, and many studies have shown that their germinability is unaffected by the treatment.

Along comes ARS plant physiologist Aref A. Abdul-Baki, of the Agricultural Marketing Research Institute in Beltsville, Md., with evidence that washing seeds with water after treating them with NaOCl does not indeed remove all the disinfectant. Furthermore, Dr. Abdul-Baki says the treatment designed to remove one impediment to reliable research on seeds actually creates others that may be just as objectionable. While the NaOCl kills pathogenic organisms, it is also responsible for misleading information because of its effect on seed metabolism.

Dr. Abdul-Baki came upon this effect in the course of his research on the relationship between the quality of a seed and its capacity to synthesize proteins. He had been immersing seeds in water containing radioactive amino acids, then observing the conversion of these amino acids into proteins by the seeds. The work had shown that during the very early hours of germination, a vigorous seed is more effective in making this conversion than a deteriorated one.

When one of the amino acids Dr. Abdul-Baki was working with began giving confusing results, he suspected that the disinfectant was playing an unexpected and unwanted role. In spite of thorough washing in water, the sterilized seeds still had NaOCl on their surface. This NaOCl, he showed, was capable of breaking the amino acids down into three products: carbon dioxide, ammonia, and aldehydes.

Obviously, to the extent that such a breakdown occurred, the amino acid would not be available to the seed for synthesis of proteins. In addition, some of the aldehydes produced are potent inhibitors of germination. Their build-up around the seed could be expected to result in further metabolic disorders.

Besides breaking down the amino acids, NaOCl reacts strongly with many organic acids that are essential intermediates in seed metabolism. Indoleacetic acid, for example, is rapidly destroyed by NaOCl. The acid is a hormone, native to all plant tissues, and regulates such vital functions as root initiation and fruit setting.

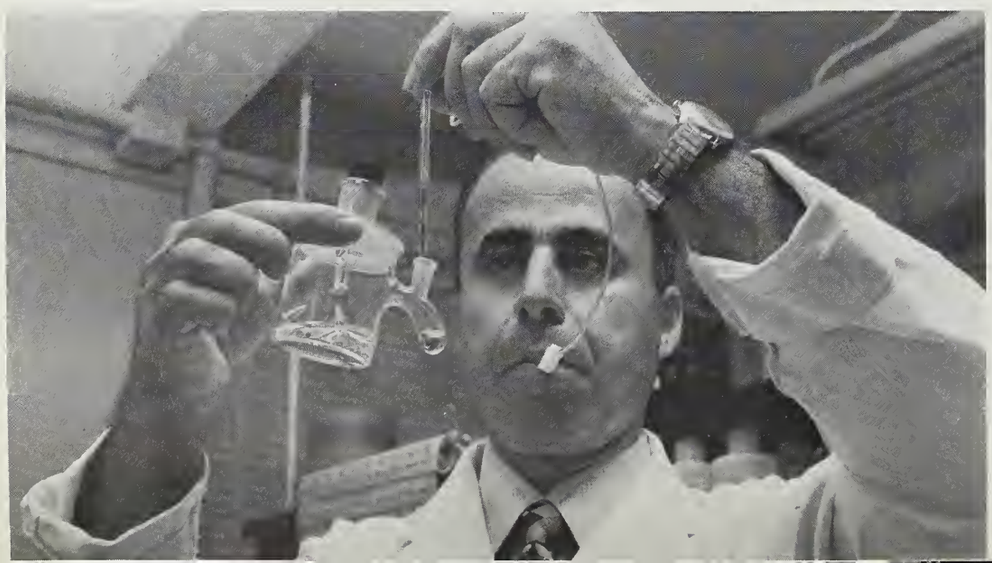
Hypochlorite also has an effect on the seed itself, Dr. Abdul-Baki found. The disinfectant permanently alters the permeability of the seed coat, probably by oxidizing its major components. This makes it easier for some amino acids to get through the coat to the embryo, and harder for others. Here again, the availability of free amino acids to the cell is affected, as would be the amount of newly synthesized protein.

What can be done about NaOCl used as a seed disinfectant? It is so tightly absorbed to the seed surface that it cannot be completely removed by rinsing, even after several hours under running water. Even if it were effective, such extended washing would be injurious to the seeds of many species.

Dr. Abdul-Baki showed that a 5-minute soaking in dilute hydrochloric acid (HCl) removes most of the effects of NaOCl from sterilized tomato, lettuce, and barley seeds, the ones with which he did his research. The HCl treatment reduced their amino-acid breakdown to a level close to that experienced with unsterilized seeds. Whether other seeds would withstand HCl treatment is yet to be shown in his studies.

Removal of the NaOCl will not, however, reverse the effect of the sterilant on the seed coat. Thus it appears that some substitute for hypochlorite will have to be found that will sterilize satisfactorily without affecting seed germination. Until and unless the search for such a substitute is successful, researchers will have to be sure that the sterilized seeds or other plant tissues they use for metabolic studies are free of hypochlorite. □

Dr. Abdul-Baki isolates products of the reaction between sodium hypochlorite (NaOCl) and amino acids in a special compartmentalized flask. The effects of these reaction products, which contain aldehydes and organic acids, on sterilized seeds and other plant tissues used in metabolic studies are being studied by ARS scientists (0774R1016–23).



A technician from a company specializing in freeze-marking lifts a super-chilled copper marking stamp from a solution of dry ice and alcohol. Horse owners were among the first to recognize the precise and humanitarian Angle System of animal identification (Brand-0-6).

A better mark

IF EVERYONE on this planet spoke a different language, communications would be chaotic to say the least. Yet this is the sort of situation animal owners throughout the world face. There is at present no universal system for identifying animals, but if a recently-proposed numeral system is adopted, there soon might be.

ARS veterinarian R. Keith Farrell, Pullman, Wash., believes his numeral system, called the Angle System, is capable of providing a universal animal identification code. Derived from the ancient Arabic numeral system, the Angle System follows the basic principle that straight lines are easy to make with crude instruments. It offers simplicity, preciseness, and universal application; readily lends itself to a computerized data retrieval system; and above all, provides good visual communication.

Good visual communication is necessary to make the information useful to large and diverse audiences, and for recording such information for history. Present animal identification symbols are often repetitious, confusing, and easily reproduced. Symbols used in one State might be unintelligible in another State, let alone another country. Clearly, a single identification system that will be accepted internationally would be worth untold millions to those involved in livestock production.

The Angle System is easily understood and remembered. Visualize a basic square: this represents the even numbers in the system. The number 2 occurs in the upper-left-hand corner of the square. Numbers 4, 6, and 8 occur in the square's right angles revolving clockwise from the number 2.

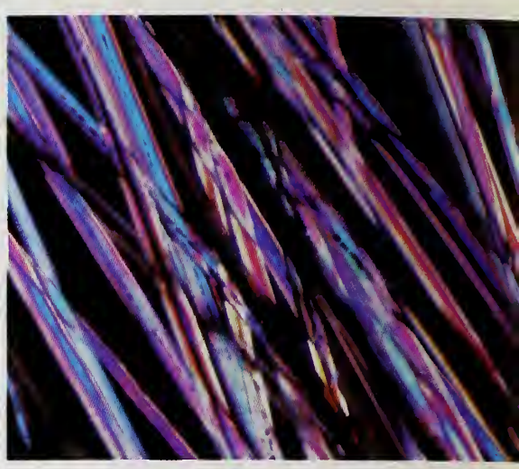
Next, rotate the basic square 45 degrees. Odd numbers will now occur at the right angles between the even-numbered corners of the original basic square. For example, 3 falls between 2 and 4. The number 1 is represented by two vertical lines, and zero is formed by two horizontal lines.

With very little practice the Angle System becomes more logical than the original Arabic System. In fact, Dr. Farrell's method requires only a single marking rod with a right angle engraved on one end, and a straight line at the other, to be fully operable.

Dr. Farrell has also developed two marking techniques—freeze-marking and laser beam marking—to accom-

A better mark

Below: An Appaloosa mare and her colt gambol on the Palouse country of Washington. The Appaloosa was prized and bred by the Nez Perce Indians for its distinctive white and patterned markings (Brand-0-4). Upon the advent of freeze-marking, a few dishonest horse dealers learned that the technique could be employed to "counterfeit" Appaloosa horses. This practice came to a halt when researcher Thomas Bell discovered that, under a microscope, freeze altered horse hair would show rainbow hues (above right) when subjected to polarized light (Brand-0-7). The silvery sample of true Appaloosa hair (below right) defracts or bends less light under the same polarized light source (Brand-0-8).



Dr. Farrell examines a freeze-marked deer while another of his affectionate charges nuzzles him. He is marking several species of wildlife in cooperation with the game departments of Washington, Oregon, and Idaho. Game managers will use freeze-marking along with other identification techniques to study territorial behavior, population densities, and migratory habits (Brand-0-10).

pany his Angle System. Together with the Angle System these two techniques could conceivably reshape animal identification practices throughout the world.

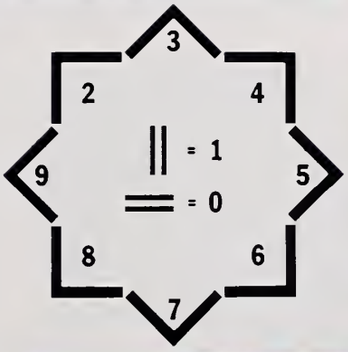
FREEZE-MARKING

A struggling animal's pain-filled shrieks, burnt flesh's acrid smell, and the terrible sight of an iron branding rod, glowing red from the heat, should hopefully soon be shunted into history, thanks to the technique called "freeze-marking."

Branding as a means of identification dates back to early civilization when people were branded as slaves or thieves. Despite popular notions of branding and the "Old West," people have been reluctant to brand animals. Besides inflicting extreme pain, hot branding damages the animal's hide, and leaves open wounds that are susceptible to insect infestation and infection.

Noting that these drawbacks—cou-

Horse registries and associations adopting the alpha-angle system of freeze-marking use a code composed of an initial alpha character identifying the association and a series of angles designating the horse's birth date and identification number. According to the code (diagramed at right) the marking stamp above represents a horse of Appaloosa registry, born in 1972, with identification number 163132. Applied to the registry form with ink and on the animal by freeze-marking, the symbols become the horse's lifetime identification. (Brand-0-9).



Freeze-marked just minutes before, this horse grazes contentedly. The welts, caused by the intense cold, are painless and will disappear in a few hours (Brand-0-5).

pled with fire branding's blurred, runny, and general poor quality—make for a sorry identification technique, Dr. Farrell proposed freeze-marking as a desirable alternative.

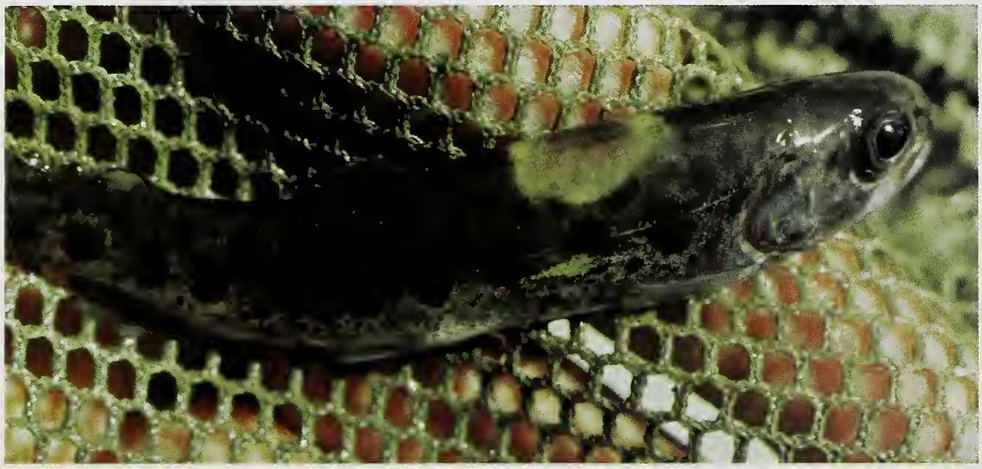
Called freeze-marking to escape painful associations with the term "branding," the technique utilizes heavy copper stamps, or marking rods, chilled in either liquid nitrogen or dry ice, and 95 percent alcohol. The area to be marked is shaved and scrubbed with a 95 percent alcohol wetting solution to aid in conducting the intense cold and to withdraw body heat.

Placing the copper stamp against the animal's body for 10 to 20 seconds destroys pigment producing cells (melanocytes) to produce a pigment-free skin area. Hairs growing back in this area will be white. Longer application times result in more balding, a condition necessary for producing legible marks on white or light-colored animals.

A freeze-mark that produces white

A technician's electric clippers reveal a perfect and unalterable Angle System freeze-mark applied to this pony six months before by Dr. Farrell (right). Mrs. Farrell looks on (Brand-0-3).

Above: Dr. Bell watches through protective goggles as a fish held by a rotating vacuum is "zapped" by the pigment altering ruby laser. The digital analyzer in the foreground indicates the intensity of the laser's 30 billionth of a second pulse. (Brand-0-11). Below: A steelhead trout fingerling with a permanently altered pigment area shows the results of the laser-marking (Brand-0-12).



hair, causes only minimal changes in the hide and does not seriously impair leather properties. Freeze marks that produce baldness cause some permanent scarring and hide damage. Severe freeze-mark damage, however, is minimal compared to fire brand damage.

Freeze-marking is more legible than fire branding. Marks are much more distinct, and last just as long. No open wound is produced, which cuts out disease and insect infestations, and freeze-marking is relatively painless. Once, to demonstrate the painlessness of the operation, Dr. Farrell freeze-marked himself!

FENCING IN THE OCEAN

Imagine a pasture the size of the Pacific Ocean. Imagine this pasture unfenced. Your stock mingles with a myriad of other critters, contracting diseases unknown to you. Your breeding program suffers because you can only mark a fraction of your herd, and even then your success is based on after-market opinions of people you do not know, in thousands of markets scattered throughout the world.

With diminishing land resources and increasing populations, mankind will be turning more and more to the sea as a source of food, but the present situation of nations and their fishing rights within their territorial waters is tense. Native stock now roam the seas openly, presenting poachers a golden opportunity. The Japanese-Soviet Union-United States-British Columbia Pacific Treaty Agreement establishes fishing parameters, but present non-automated identification techniques do not allow for sufficient recoveries of marked fish from the high seas to enforce this or other similar agreements.

Dr. Farrell's laser marking technique provides a solution for the fish culturist's problems. By using lasers to inactivate pigment producing cells in fish, he can quickly mark the fish for identification.

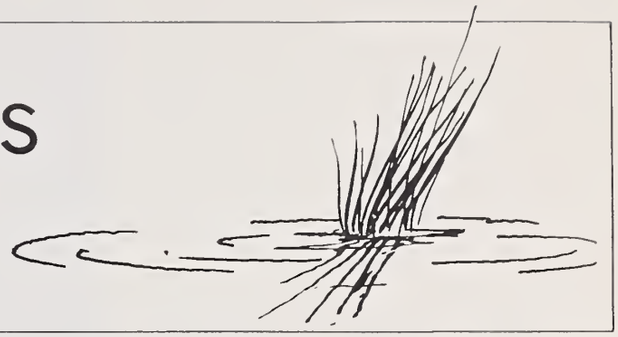
The beam is applied while the fish is submerged in water. The water-skin interface allows a beam penetration that destroys the melanocyte, a one-celled gland that secretes color pigment, leaving a permanent white mark in its stead. The laser is applied in 30 billionths of a second and does no significant damage to the fish.

The technique requires more field testing, but the capability to mark fish at machine gun speeds might one day enable people to mark every fish from every hatchery in the world, with a different mark for each hatchery, and thereby revolutionize the fishing industry.

UNIVERSAL ANIMAL IDENTIFICATION

The Angle System, along with fast and efficient marking techniques such as freeze-marking and lasers, will vastly improve recordkeeping and registration of animals and fish. This in turn will improve disease prevention by enabling veterinarians to trace disease origins. Eliminating variations in State and national identification procedures will cut out costly and time-consuming efforts to coordinate such different registrations. Animal theft will become less profitable, for the chances of a stolen animal being identified and returned to its owner will be far greater if a universal identification system is adopted.

Carbofuran controls rice water weevil



WHETHER it's Creole Gumbo, pudding, or curry, rice is a national food favorite and an international staple. Unfortunately, the rice water weevil usually gets the first taste. ARS entomologists may have found a way to take the bite out of the weevil and the larvae out of the field.

In large-field and small-plot tests, populations of small and medium sized larvae were significantly reduced and 70 percent of the large larvae were killed after treatment with carbofuran, an insecticide approved for use on rice in 1971.

As long ago as 1881, *Lissorhoptrus oryzophilus* Kuschel was identified as a major pest of rice. For more than 75 years, draining and drying the fields was the only means of control, and even that was inadequate.

Twenty years ago, sprays of organochlorine materials were broadcast on the soil surface before the fields were flooded. This effectively controlled the destructive larval stage. Since then, numerous broadcast insecticide formulations and seed treatments have been used to prevent an anticipated infestation.

The weevil still gets there first. Root pruning (feeding by larvae) often reduces rough rice yield up to 1,000 lbs. per acre. In the past, insecticides have not been used to control a weevil population in existence at the time of treatment. They have been applied at planting or flooding of the rice to control larvae that hatch after flooding or 3 to 6 weeks after treatment.

Adult reinfestation of treated fields frequently produces large populations of larvae with subsequent root pruning continuing for 8 or more weeks after flooding. "Growers have to let late larval infestations go, hoping for the best," said ARS entomologist James R. Gifford. "A greater yield can be achieved by controlling the larvae before the serious damage occurs."

At the Rice Insects Research Laboratory, Baton Rouge, La., Mr. Gifford and agricultural technician George B. Trahan, with the late Dr. Billy F. Oliver of Louisiana State University, have demonstrated that systemic insecticides applied up to 5 weeks after flooding may provide an additional 4 to 6 weeks control, prevent infestation and, as a result, increase rice yields.

Researchers ran two small-plot trials with "Saturn" rice, drillplanted in plots 7 or 8 rows wide, 24 ft. long, row-spaced at 7 in., with 3 ft. between plots. Carbofuran 3-percent granules (½ lb. of active ingredients per acre) were distributed by measured shaking from a jar with holes in the lid to produce the desired flow. Treatments consisted of a single application made 1 to 5 weeks after flooding. The plots were sampled 25 to 28 days after flooding and every 4 to 7 days throughout the following 6 weeks. When all sizes of larvae were pooled for analysis, data showed that carbofuran applied at 1, 2, 3, or 4 weeks postflood, significantly reduced larval infestation.

All plots were harvested by combine; grain moisture was measured for each treatment replication and yield of rough rice per acre was determined. "All treatments in both trials produced yield increases ranging from 86 to 614 lbs. more rough rice per acre compared to untreated plots," Mr. Gifford said.

Five large-field trials were conducted in five southwestern Louisiana parishes to see what would happen when carbofuran was applied commercially by aircraft 2 and 3 weeks after the rice seedlings were flooded. Seven other fields were sprayed 2 weeks after flooding. Strips ranging from 2 to 5 acres were treated by five or more 33-ft. wide aerial swaths.

A single application of carbofuran applied broadcast by researchers Gifford and Trahan at 2 and 3 weeks after the seedlings were flooded, reduced the larvae 81 percent and 88 percent, respectively, and provided root protection for 2 to 3 weeks longer than current control practices.

With carbofuran application, the ultimate savings in rice yields might be enough to shower brides and grooms from Salem to Seattle. □

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Boosting beef production. . .

. . . Raising AI conception rates

RANCHERS can obtain 6 more calves for every 100 cows bred at a cost of 10 seconds more labor at each breeding, using a method developed by ARS to increase conception rates in artificially inseminated cows. For meat consumers this could mean millions more pounds of beef on the market each year.

ARS studies show that cows receiving 10 seconds of manual clitoral massage following artificial insemination averaged 58.4 percent conception, while cows not receiving clitoral massage averaged 52.1 percent conception. The 6.3 percent advantage means an increase to ranchers in gross calf receipts of more than $1.2 million for every 1 million cows inseminated.

The introduction of semen from exotic cattle breeds into the U.S. beef industry has generated a great deal of interest in artificial insemination over the last several years.

Work at the U.S. Range Livestock Experiment Station, Miles City, Mont., has been aimed at bringing artificial insemination conception rates up to a par with those of cows served by bulls.

Understanding the sequence of events which results in a pregnant cow is important to successful artificial insemination. A structure on a cow's ovary called a follicle contains the egg. Stimulated by a hormone from the pituitary gland, the follicle produces estrogen which causes the cow to come into standing heat, a period called estrus. Estrogen also causes release of luteinizing hormone from the pituitary gland, which in turn causes ovulation or release of the egg from the follicle. The egg then enters the cow's uterus.

Since the sperm and the egg have a rather short life, ovulation must occur close enough to artificial insemination to insure the presence of fertile sperm at the site of a fertile egg. Hastening ovulation increases the chances of having live sperm present, hence increases chances of conception.

ARS physiologist Ronald D. Randel synchronized estrus in 39 cows by feeding each cow 180 milligrams (mg) of medroxyprogesterone acetate each day for an 11-day period. On the second day of this period, he injected each cow with 5 mg of estradiol benzoate.

At estrus, cows were grouped into five categories: no mating stimulation; cervical stimulation; cervical stimulation plus 10 seconds of clitoral stimulation; served by a bull; and estrus checked and served by a bull. Homosexual behavior among cows not served by bulls verified they were in heat.

Ten seconds of manual clitoral massage shortened the time lapsed between the start of estrus and ovulation. Cows receiving cervical and clitoral massage ovulated 4.7 hours earlier than cows receiving no mating stimulation, much the same as cows served by bulls.

Stimulation of the cow's reproductive tract also aids sperm transport. As the female reproductive tract must carry the sperm to the egg, this factor alone could increase cow conception rates, but when combined with the speeding up of ovulation, the resulting increase in conception rates should please both ranchers and the meat-eating public. □

Standing to the right of the tree, a sterile test bull nuzzles a cow, perhaps to learn if she is in heat. When the cow stands for the bull to mount her, researchers know that the cow has come into heat and can be artificially inseminated. ARS researchers in Montana are studying ways to increase artificial insemination conception rates (PN–2782).

. . . Weaning fall calves earlier

Young fall-born calves are being weaned at 56 days of age at the U.S. Meat Animal Research Center. Calves are conventionally weaned at about 200 days of age. Early weaning will permit the mothers of these calves to be re-bred sooner, increasing potential meat production from the cowherd (1173W1692–33).

Weaning fall beef calves early—at about 2 months of age instead of the usual 6½ months—increases reproductive efficiency of young cows.

In studies at the U.S. Meat Animal Research Center, Clay Center, Nebr., early weaning increased the percentage of cows coming into heat in a 42-day breeding season. Pregnancy rates, as a result, increased 26 percent in 2-year-old cows, 16 percent in 3-year-olds, and 8 percent in mature cows, when compared with pregnancy rates of similar cows whose calves were weaned at the conventional time.

Whether or not early weaning would be an efficient practice depends upon the management and feed production situation, ARS physiologist Danny B. Laster points out. He says early weaning may be an effective management tool with young- or late-calving cows in colder regions, particularly when crop residues or pastures would support fall grazing by the cows but are inadequate for cow-calf pairs. Early weaning might be similarly useful in emergency drouth situations. Other possible applications include cow herds managed for fall calving or in semiconfinement.

Dr. Laster evaluated early weaning with 308 Hereford, Angus, Charolais-cross, Red Poll, and Brown Swiss cows ranging in age from 2 to 11 years. The calving period extended from August 7 to October 12, and the 42-day breeding period began 28 days after the last cow had calved. Eight days before the start of the breeding period, calves were weaned from 98 of the cows. Calves from the remaining 210 cows were weaned at the conventional time. The early-weaned calves ranged in age from 34 to 76 days, with an average age of 55 days. All cows were maintained on pasture and were bred by artificial insemination.

Early weaning increased the percentage of cows coming into heat from calving through the breeding period by 29 percent in 2-year-olds, 27 percent in 3-year-olds, and 16 percent in cows 4 years of age and older. In the first 21 days of breeding, early weaning increased the percentage of 2- and 3-year-old cows ready to breed by 39 and 24 percent, respectively, but did not similarly affect mature cows.

Dr. Laster says the calving date also influenced the interval from calving to first breeding in cows of all ages. Cows calving earlier in the season were ready for breeding in a shorter time. The intervals from calving to coming into heat, and from calving to first breeding, were longer in Brown Swiss cows 4 years of age and older than in cows of other breeds.

The number of inseminations per conception was not influenced by early weaning. There was no effect on calf gain up to 1 year of age. □

Cleaning tomatoes with less water

Soft, rubber disks, originally designed by ARS engineers for removal of peel from caustic treated fruit, have been employed in an experimental processing line to clean tomatoes, using less water than conventional methods (PN–2874).

CANNING TOMATOES requires lots of water and at the same time produces lots of effluent, often making it difficult for canners to meet pollution standards.

This problem has been even more acute since the advent of mechanical harvesting. These machines pick up more dirt, leaves, and stems and leave more smear soil on tomatoes, which is difficult to remove. Tomatoes delivered to canneries may carry up to 2 percent by weight of soil clods and can be covered with up to 0.2 percent by weight of smear soil.

Presently, all of this dirt is removed at canneries by water flumes and high pressure water sprays. Total water consumption in cleaning often exceeds 500 gallons per ton of tomatoes.

With a new process being developed by engineers at the Western Regional Research Center, Berkeley, Calif., this water usage could be reduced to about ½ the current requirements and reduce the effluent coming out of a processing plant by an equal amount.

To achieve these reductions, ARS engineers Robert P. Graham, Marcas R. Hart, John M. Krochta, and Gerald W. Williams modified a piece of equipment initially designed and developed at the Center for removal of peel from caustic treated fruit (AGR. RES., Sept. 1971, p. 15). The original dry peeling machines are now used by commercial vegetable processing plants. A further modification of the disc peeling principle is now used for fruits such as peaches and apricots.

With conventional cleaning, tomatoes are first dumped into a recirculated water flume (dump flume). The tomatoes are sent on to additional flumes and finally carried under high pressure water sprays to complete removal of the most difficult to remove soil.

The ARS-designed machine saves water and reduces pollution by replacing energy usually supplied by the water sprays with mechanical energy supplied by spinning, soft rubber discs.

The discs, which are 1/32-inch thick and 4¼-inches in diameter, are mounted ⅞-inch apart on steel shafts. The parallel-spaced shafts are 3-inches apart, thus providing 1¼-inches overlap between adjacent rows of staggered discs. These spinning discs replace the flumes and sprays which follow the dump flume.

After small-scale testing of the concept, the Center enlisted the cooperation of the National Canners Association and a commercial cannery to test the approach on a larger scale. They also conducted tests on this machine for lye peeling tomatoes.

Engineers at the Center constructed a tomato processing line which included a dump tank and a rubber disc unit measuring 10-feet long and 1-foot wide for cleaning. After leaving the dump tank, the tomatoes were conveyed to the rubber disc unit where the discs, spinning at 400 revolutions per minute, moved tomatoes over the unit. At the same time it wiped off smear soil and

threw heavily soiled water into a collection tray beneath the unit.

Water adhering to the surfaces of the tomatoes from the dump tank was sufficient to keep the discs wetted and promote soil removal by wiping. Only 5 gallons of fresh water per ton of tomatoes was applied as a fine mist spray for a final rinse over the last 2 feet of the disc unit.

In addition, the disc unit successfully removed 40 to 70 percent of the stems still attached to the tomatoes after harvest. This processing line handled up to 5 tons of tomatoes per hour.

The National Canners Association, with financial support from the Environmental Protection Agency, demonstrated a 30-ton per hour disc cleaner with minimum water use on a round-the-clock basis during the 1974 harvest season. Under study are various physical treatment techniques to allow recirculation of dump flume water. This will reduce water use even more.

Meanwhile, engineers at the Center are cooperating with the University of California at Davis in a study to reduce the number of soil clods that the mechanical harvester picks up along with the tomatoes. □

Engineering aide Roger Tolentino checks operation of the rubber disc cleaner in the foreground while another aide, John L. Hansen, controls the flow of tomatoes from the dump tank (PN–2873).

Nitrogen aids saline soils

NITROGEN FERTILIZERS may enable farmers to increase stands of salt-tolerant grasses on saline or salt-affected soils that were once of marginal use to agriculture.

A 2-year ARS study showed that for every pound of nitrogen fertilizer applied to a field of salt-tolerant grass at a rate of 80 pounds of nitrogen per acre, forage yield increased 22 pounds per acre.

Saline soils affect plants several ways—all usually bad. As soil water salt concentrations increase, a plant's ability to use the water decreases to the point of being unable to extract any water even though the soil is wet. Salinity also restricts plant growth by unbalancing nutritional elements in the soil water, without causing any visual symptoms except for stunted growth.

ARS technician Robert H. Ford and soil scientists Francis H. Siddoway and Alfred L. Black, of the Northern Plains Soil and Water Research Center, Sidney, Mont., initiated the work to determine the potential of nitrogen and phosphorous fertilizers for increasing crested wheatgrass production on nonirrigated saline land.

The researchers applied nine treatments ranging from 0 to 160 pounds of nitrogen per acre to crested wheatgrass grown on nonirrigated saline land that is typical of tributary lowlands in the northern Great Plains. Nitrogen was applied in the form of ammonium nitrate. In three of the nine treatments, phosphorous, in the form of superphosphate, was applied in combination with the nitrogen.

Despite a dry winter and dry soil conditions during the first year of the test, nitrogen fertilizer increased grass yields and height enough to enable harvesting of the forage. Crested wheatgrass on adjacent, nontreated fields remained too short to be cut from hay. Nitrogen also increased crude protein content of the grass sufficiently so overwintering beef cows did not need a protein supplement. Phosphorous did not influence yields or protein content that first year.

In the study's second year, a "wet" year, the carryover response of crested wheatgrass to nitrogen applied the previous year was almost double the initial response. The grass also responded to phosphorous in combination with nitrogen in the second year but 80 pounds of nitrogen per acre and no phosphorous proved the most efficient fertilization method for forage production. Had precipitation been low both years, the grass would still have responded to the nitrogen, although the response would not have been so dramatic.

During this period of short fertilizer supplies, the ARS research team cautions farmers to compare expected returns from use of fertilizer to produce hay crops on saline soils to expected returns from using the same fertilizer on alternative crops before fertilizing saline lands. No fertilizer should be applied until soil tests have been made to determine the salt status and nutrition-supplying capacity of a soil. This information is essential to sound decisions on alternative uses of fertilizer. □

Johnsongrass sentenced to drowning

Death by drowning is the recommended sentence for the chronic offender, johnsongrass. Because natural flooding of cropland by streams seems to provide some control of johnsongrass, soil scientists believe planned fallow flooding of fields offers an additional method for controlling this major weed pest of sugarcane.

The primary control measure for johnsongrass is repeated fallow plowing of sugarcane fields during the intercycle year—following 3 successive years of sugarcane production—when the soil is prepared for planting the new crop. Fallow flooding can be as effective as fallow plowing in controlling the johnsongrass rhizome, a horizontal, thickened plant stem which produces shoots above and roots below, and seedling johnsongrass, concluded ARS scientists at Louisiana State University, Baton Rouge, La. They found fallow flooding does not seriously reduce the yield of the sugarcane crop.

The scientists reached five other conclusions based on experiments with 7-, 5-, and 3-month sequentially flooded impoundments (water-holding areas) in plots of Mhoon silty clay loam soil, precision graded to a surface slope of 0.1 percent, which was heavily infested with johnsongrass.

- Seedling emergence in post-treatment greenhouse evaluation decreased significantly (99-percent level) as the duration of the flooding increased.
- Less aquatic weed growth was observed on plots treated with sugarcane bagasse, the stalky residue remaining after juice has been extracted, than on plots not treated during the flooding.
- Johnsongrass plant emergence before flooding the last impoundment (of 3-month duration) was visibly reduced where bagasse had been incorporated in the soil.
- Flooding duration of less than 3 months did not significantly reduce emergence of seedling johnsongrass.
- Cyclic flooding and draining of fields may also be necessary to promote germination and devitalization of additional johnsongrass seed.

Scientists point out the importance of discing the soil surface of the impoundments once after levees are constructed and immediately before the first impoundment is flooded. Preferably, the field should be precision-graded, with low slopes so that levees can be spaced sufficiently far apart.

The potential economic advantage is that a shorter time may be needed for fallow flooding than for fallow plowing.

This may allow an additional cash crop to be grown. Also, the cost of fallow flooding can be minimized by using waste water from the sugar mill.

ARS agricultural engineer Carl R. Camp, microbiologist James F. Parr, and soil scientist Barby R. Carroll, cooperated with Louisiana State University agricultural engineer Mansel M. Mayeux on the project. □

Limiting the cornborer's travel plans

An unwelcome tourist, the southwestern corn borer (*Diatraea grandiosella* Dyar) is traveling north and east and soon may be sunning itself on the Atlantic coast. While early planting of corn and fall discing have been recommended to reduce losses caused by the corn borer, fall and spring rains often make such cultural practices difficult to use. Critical timing and costly insecticide applications also pose problems.

Unlike the European corn borer (*Ostrinia nubialis*), the southwestern corn borer does not overwinter in the northern Corn Belt States. The southwestern corn borer has been reported as far north as northcentral Missouri while the European corn borer reaches as far south as northern Mississippi.

In Mississippi, scientists designed studies to screen corn germplasm for resistance to first- and second-brood corn borer damage. First-brood damage results from leaf feeding in the whorl of the plant by the larvae, while second-brood infestation occurs when the plants shed pollen—sometimes shortly after. Larval damage is primarily caused by the larvae tunneling in the stalk, but they also feed in the ears, ear shank, and husks.

After rearing the insect in the laboratory, scientists allowed the moths to lay eggs on sheets of waxed paper from which disks containing eggs could be punched out and handled. These disks were pinned to the upper leaves in the whorl of the corn plant to establish the first-brood infestation.

Each plant received two applications of 15 eggs per application within a 3- to 7-day interval.

"From results with replicated trials, we have recently released an inbred line, Mp496, which has good resistance to first-brood larval feeding," said ARS agronomist Gene E. Scott at the Plant Science Laboratory in Mississippi State, Miss. "This line rates a 6 on a rating scale of 1 to 9, with 1 indicating a very high level of resistance and 9 indicating susceptibility. The rating obtained on most genotypes is 9. The most resistant lines we tested were kept and self-pollinated."

Some of the best of these rated a 4.5 to 5 in July 1974. Although the most promising resistance found to date has been among genotypes from South and Central America and Mexico, several southern genotypes have shown resistance to second-brood attack.

"Dissection of infested plants has shown that the number of surviving larvae was drastically reduced and those that did survive were smaller," reported ARS entomologist Frank M. Davis. Preliminary data have shown that resistant material had only 14 percent as many surviving larvae as found in susceptible material. □

About Dicop and salmon

THE ARTICLE "New Chemical Saves Fish Facility" (September, 1974) stated that Dicop can be used safely while salmon are in the egg, alevin, or fry stages. When these bioassay tests were made, however, King salmon were unavailable, so steelhead trout were substituted and the tests results extrapolated to King salmon.

Algae are presently controlled with Dicop in the presence of juvenile and adult salmon. While researchers are optimistic that King salmon (eggs, alevins, and fry) will prove as tolerant to Dicop as did steelhead trout, this will be established with certainty only after further testing with King salmon.

Eliminating flies

VERY OFTEN, small biting flies are overlooked as a pest to man and livestock. One in particular, *Culicoides variipennis*, commonly attacks cattle, horses, swine, sheep, and deer. These blood-sucking insects, which are found in all parts of the country, occasionally feed on humans.

This insect is the primary vector or carrier of bluetongue, a serious disease affecting cattle and sheep. *C. variipennis* is also a vector of epizootic hemorrhagic disease (EHD) of deer. This disease may also affect cattle.

Large numbers of these flies attack livestock and often adversely affect meat and milk production. They often cause a scabby condition along the belly and on the udder or teats of livestock. Swarms of the insect have even caused open wounds.

One bite from this small fly is just as dangerous in infecting cattle with bluetongue or EHD as a bite from a larger fly. By reducing the populations of *Culicoides*, farmers and ranchers greatly reduce odds for the spread of these diseases.

Many populations of this species are the direct result of poor water management practices and control can often be accomplished without the use of insecticides.

According to ARS entomologist Robert H. Jones, at the Arthropod-borne Animal Disease Research Laboratory, Denver, Colo., the easiest way to control the flies is by eliminating breeding areas for larvae. Improper disposal of livestock and human wastes often creates excellent sites.

Leaking and overflowing water tanks and troughs should be corrected to prevent water loss onto the ground. Ditching will also prevent water accumulation.

Larval breeding in dirt stock tanks is prevented if the margins are relatively steep, about 30 degrees. Hard packed soil is also effective. Farmers and ranchers should avoid letting manure or mud areas extend into shallow water.

They should attempt to maintain a high water level in ponds. During drought, after irrigation, or with the gradual lowering of the water level, soft mud margins or central mud banks are often exposed, creating excellent breeding sites of *C. variipennis*.

Dr. Jones also recommends that septic tanks be properly installed or cleaned regularly to prevent the formation of muddy drainage slopes further down hillsides.

More sugar

CORRECT TIMING in applying the herbicide diquat to two varieties of Hawaiian sugarcane could increase yields of sugar on lands already producing more than 10 tons of sugar per acre.

Diquat is used in Hawaii to prevent flowering the first year of a 2-year crop. From results on other varieties, growers have generally applied diquat between the 4th and 12th of September, but the herbicide has not been "taking" on two varieties that rank number 3 and 4 in total acreage on the islands.

Those varieties—H54–775 and H57–5174—comprise about 30,000 acres of Hawaii's total sugarcane acreage.

ARS plant physiologist Paul H. Moore finds that by applying diquat to H54–775 on or before September 4, flowering can be controlled. On the other hand, application of diquat to H57–5174 should not take place until around September 20. When both these dates are observed, about 80 percent of the flowering can be stopped.

Hawaii is one of the few spots in the world that has a 2-year sugarcane crop. If there is heavy flowering the first year, the sugarmaking ability of the cane is shortstopped, and in a sense the crop ends up as a 1-year crop. After flowering, sugar production stops.

Proper timing of diquat application will allow the growing of these two varieties in areas where they were previously excluded because those areas typically produce heavy flowering during the first year.

Dr. Moore is stationed at the Hawaiian Sugar Planters Association in Honolulu.

Correction: Root-knot photo

A PHOTO accompanying an article on root-knot of vegetables on page 17 of our October 1974 issue carried an erroneous caption. The photo depicted an infection caused by the potato cyst nematode, not the root-knot nematode. Also, annual nematode-related losses in vegetables at the current price base may be closer to $500 million, not $2.5 million as reported.

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Insect-free dried fruit

SCIENTISTS have developed an insecticide-treated bag that virtually eliminates insect damage to dried fruits during storage. Use of the bag could eliminate some of the $230,000 annual loss for stored prunes. The bag, already in limited use on prunes, was developed by ARS.

In tests, the bag completely protected prunes from insect damage for at least 6 months in areas with high insect infestation. The bag was also effective for protecting raisins and mixed fruits such as apricots, pears, prunes, and peaches. The same tests also showed that 96 percent of the bags made from other than the new type of material were infested with insects and thus unacceptable for human consumption.

The bag is made of .0015 inch-thick, waterproof cellophane laminated with .0005 inch-thick adhesive to .00125 inch-thick polyethylene. The insecticides pyrethrins and piperonyl butoxide are incorporated into the adhesive layer at concentrations of 5 and 50 milligrams per square foot, respectively.

Prunes stored for 6 months with the above concentrations of insecticides had no pyrethrins residue and only a 1.4 part per million (ppm) residue of piperonyl butoxide. The Environmental Protection Agency has set tolerance levels of 0.3 ppm for pyrethrins and 3.0 ppm for piperonyl butoxide for prunes stored in these bags. Last fall the FDA approved the bag for use with all dried fruit products.

ARS entomologist Albert P. Yerington, at the Stored-Product Insects Research Laboratory, Fresno, Calif., conducted the tests in an insect exposure room containing about 70,000 insects, some of which can bore through package walls. These insects, consisting of nine species, were in all stages of development and were reared in the laboratory and released in the room at 2-week intervals.

The insects included the merchant grain beetle (*Oryzaephilus mercator*), saw-toothed grain beetle (*O. surinamensis*), Indian meal moth (*Plodia interpunctella*), maize weevil (*Sitophilus zeamais*), red flour beetle (*Tribolium casteneum*), confused flour beetle (*T. confusum*), and three species of Dermestid beetles (*Trogoderma glabrum*, *T. inclusum*, and *T. variable*).

Diagnosing HEV

THREE diagnostic tests could be useful in surveys to determine the extent of hemagglutinating encephalomyelitis virus (HEV) infection in swine.

HEV was first isolated from swine in the United States in 1970. The virus is associated with an encephalitis-vomiting and wasting disease that may be of economic importance to the swine industry in this country.

ARS veterinary medical officer William L. Mengeling compared the agar gel diffusion, serum neutralization, and hemagglutination inhibition tests for detecting antibodies in blood serum of swine experimentally infected with HEV.

In studies at the National Animal Disease Center, Ames, Iowa, the serum neutralization test detected antibodies in 96 percent of the serum samples collected 1 to 18½ weeks after exposure of 19 pigs to HEV. The hemagglutination inhibition test was almost as sensitive, identifying antibodies in 94 percent of 128 samples. The agar gel immunodiffusion test was less than 50 percent as effective as the other two tests, but it may be of use where several samples from a herd or location are to be tested.

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